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LIGAND AND COMPLEX FOR CATALYTICALLY BLEACHING A SUBSTRATEFIELD OF INVENTION

This invention relates to a class of ligand or complex  
5 thereof useful as catalysts for catalytically bleaching  
substrates.

BACKGROUND OF INVENTION

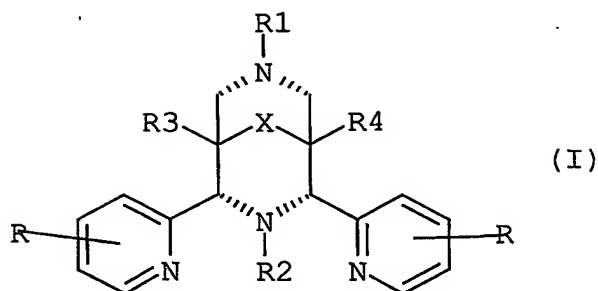
The use of bleaching catalysts for stain removal has been  
10 developed over recent years.

The search for new classes of compounds that are suitable as  
peroxyl catalysts is ongoing.

15 Various [3.3.1] bicyclo compounds and complexes thereof are  
discussed in the literature, see for example: Comba P. et  
al., J. Chem. Soc. Dalton Trans, 1998, (23) 3997-4001;  
Börzel et al. Chem. Eur. J. 1999, 5, No. 6, 1716 to 1721 and  
review by P. Comba in Coordination Chemistry Reviews 2000,  
20 200-202, 217 to 245, entitled "Coordination compounds in the  
Entactic State". These compounds are discussed in terms of  
their physical properties.

WO0060045, to Proctor and Gamble, discloses a bleaching  
25 system comprising: a) from about 1ppb, by weight of a  
transition metal catalyst comprising: i) a transition metal;  
ii) a ligand having formula (I):

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wherein each R is independently hydrogen, hydroxyl, C1-C4 alkyl, and mixtures thereof; R1 is C1-C4 alkyl, C6-C10 aryl, and mixtures thereof; R2 is C1-C4 alkyl, C6-C10 aryl, and mixtures thereof; R3 and R4 are each independently hydrogen, C1-C8 alkyl, C1-C8 hydroxyalkyl,  $-(CH_2)_xCO_2R_5$  wherein R5 is C1-C4 alkyl, x is from 0 to 4, and mixtures thereof; X is carbonyl,  $-C(R_6)_2-$  wherein each R6 is independently hydrogen, hydroxyl, C1-C4 alkyl, and mixtures thereof; b) optionally a source of hydrogen peroxide; and c) the balance carriers and adjunct ingredients. However, the teaching of W00060045 limits substituents at the nitrogens (3 and 7 positions) of bicyclostructure to homoaromatic carbon groups, namely alkyl and aryl.

W00248310, to Unilever, in contrast to W00060045 discloses compounds having a similar core structure but with the requirement that at least one of R1 and R2 is a group containing a heteroatom capable of coordinating to a transition metal.

#### SUMMARY OF INVENTION

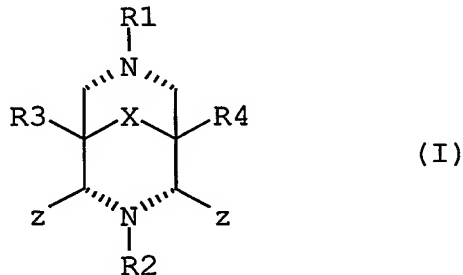
Our earlier filed application W00248301, filed 15 November 2002, which claims priority from GB0030673.8, filed 15

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December 2000, discloses the use of various bispidon compounds. Referring to the structure above, WO0248301 teaches that there is an advantage to be secured by having at least one of R1 and R2 as group containing a heteroatom capable of coordinating to a transition metal. We have now found that by having at least one of R1 and R2 as a C8-C22-alkyl chain further advantages are secured.

The present Invention provides a bleaching composition comprising:

a) a monomer ligand, L, or transition metal catalyst thereof of a ligand having the formula (I):



wherein R1 and R2 may be selected from the group consisting of:

a group containing a heteroatom capable of coordinating to a transition metal;

a -C1-C22-optionally substituted-alkyl;

a -C6-C10-aryl;

a -C1-C4-alkyl-C6-C10-aryl; and,

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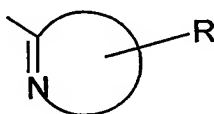
wherein at least one of R1 and R2 is a non-aromatic hydrocarbon group, the non-aromatic hydrocarbon group being a C8-C22-alkyl chain;

- 5 R3 and R4 are independently selected from: hydrogen, C1-C4-alkyl, phenyl, electron withdrawing groups and reduced products and derivatives thereof;

10 X is selected from: C=O, a ketal derivative of C=O, a thioketal of derivative of C=O, and  $-[C(R6)_2]_y-$  wherein y takes a value 0 or 1; each R6 is independently selected from hydrogen, hydroxyl, O-C1-C24-alkyl, O-benzyl, O-(C=O)-C1-C24-alkyl, and C1-C24-alkyl;

- 15 z groups are same monocyclic or dicyclic heteroaromatic N-

donor groups of the form:



wherein R is -C0-C4-

alkyl, and,

- 20 b) the balance carriers and adjunct ingredients, together with at least 2 % wt/wt of a peroxygen bleach or source thereof.

25 It is most preferred that the peroxygen bleach or source thereof is other than that of an alkyl hydroperoxide. It is particularly preferred that the bleaching composition comprises sodium perborate tetrahydrate, sodium perborate monohydrate or sodium percarbonate in range of about 2-35% wt/wt, preferably from 5-25% wt/wt.

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In a second aspect, the present invention provides a bleaching composition comprising, in an aqueous medium, the bicyclo ligand of the general Formula (I) which forms a complex with a transition metal, the complex catalysing  
5 bleaching of a substrate, wherein the aqueous medium contains a peroxide other than an alkyl peroxide. It is preferred that the medium has a pH value in the range from pH 6 to 12 and most preferably from pH 8 to 11.

10 Catalysts of the present invention may be incorporated into a composition together with a peroxy species or source thereof. For a discussion of acceptable ranges of a peroxy species or source thereof and other adjuvants that may be present the reader is directed to United States Patent  
15 6,022,490, the contents of which are incorporated by reference.

The present invention extends to a method of bleaching a substrate comprising applying to the substrate, in an  
20 aqueous medium, the bleaching composition according to the present invention.

The present invention extends to a commercial package comprising the bleaching composition according to the  
25 present invention together with instructions for its use.

Any suitable textile that is susceptible to bleaching or one that one might wish to subject to bleaching may be used. Preferably the textile is a laundry fabric or garment.

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In a preferred embodiment, the method according to the present invention is carried out on a laundry fabric using an aqueous treatment liquor. In particular, the treatment may be effected in a wash cycle for cleaning laundry. More  
5 preferably, the treatment is carried out in an aqueous detergent bleach wash liquid.

The organic substance can be contacted with the textile fabric in any conventional manner. For example it may be  
10 applied in dry form, such as in powder form, or in a liquor that is then dried, for example in an aqueous spray-on fabric treatment fluid or a wash liquor for laundry cleaning, or a non-aqueous dry cleaning fluid or spray-on aerosol fluid.

15

In a particularly preferred embodiment the method according to the present invention is carried out on a laundry fabric using aqueous treatment liquor. In particular the treatment may be effected in, or as an adjunct to, an essentially  
20 conventional wash cycle for cleaning laundry. More preferably, the treatment is carried out in an aqueous detergent wash liquor. The organic substance can be delivered into the wash liquor from a powder, granule, pellet, tablet, block, bar or other such solid form. The  
25 solid form can comprise a carrier, which can be particulate, sheet-like or comprise a three-dimensional object. The carrier can be dispersible or soluble in the wash liquor or may remain substantially intact. In other embodiments, the organic substance can be delivered into the wash liquor from  
30 a paste, gel or liquid concentrate.

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In the alternative, the organic substance can be presented in the form of a wash additive that preferably is soluble. The additive can take any of the physical forms used for wash additives, including powder, granule, pellet, sheet, 5 tablet, block, bar or other such solid form or take the form of a paste, gel or liquid. Dosage of the additive can be unitary or in a quantity determined by the user. While it is envisaged that such additives can be used in the main washing cycle, the use of them in the conditioning or drying 10 cycle is not hereby excluded.

The present invention is not limited to those circumstances in which a washing machine is employed, but can be applied where washing is performed in some alternative vessel. In 15 these circumstances it is envisaged that the organic substance can be delivered by means of slow release from the bowl, bucket or other vessel which is being employed, or from any implement which is being employed, such as a brush, bat or dolly, or from any suitable applicator.

20

Suitable pre-treatment means for application of the organic substance to the textile material prior to the main wash include sprays, pens, roller-ball devices, bars, soft solid applicator sticks and impregnated cloths or cloths 25 containing microcapsules. Such means are well known in the analogous art of deodorant application and/or in spot treatment of textiles. Similar means for application are employed in those embodiments where the organic substance is applied after the main washing and/or conditioning steps 30 have been performed, e.g. prior to or after ironing or drying of the cloth. For example, the organic substance may

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be applied using tapes, sheets or sticking plasters coated or impregnated with the substance, or containing microcapsules of the substance. The organic substance may for example be incorporated into a drier sheet so as to be  
5 activated or released during a tumble-drier cycle, or the substance can be provided in an impregnated or microcapsule-containing sheet so as to be delivered to the textile when ironed.

#### 10 DETAILED DESCRIPTION OF THE INVENTION

The ligand as described herein is capable of dynamic inversion. The ability of the ligand to chelate to a TM depends upon the stereochemistry of the substituents. It is preferred that substituents are endo-endo, but it is likely  
15 that stereochemical conversion takes place by retro-Mannich conversion. Retro-Mannich may be prevented by changing the groups present such that retro-Mannich reactions are unfavoured. Nevertheless, it is likely that endo-exo and  
exo-exo ligands as described herein coordinate to transition  
20 metal ions in many instances and are capable of functioning as bleaching catalysts.

Referring to ligands and complexes thereof and bleaching compositions derived therefrom with respect to Formula (I),  
25 at least one of R1 and R2 groups as designated in the ligand of formula (I) must be a non-aromatic hydrocarbon group, the non-aromatic hydrocarbon group being a C8-C22-alkyl chain. The C8-C22-alkyl chain may incorporate a branched, cyclic moiety or mixtures thereof as part of the C8-C22-alkyl  
30 chain. It is preferred that the C8-C22-alkyl chain is a straight chain moiety. The following are provided as

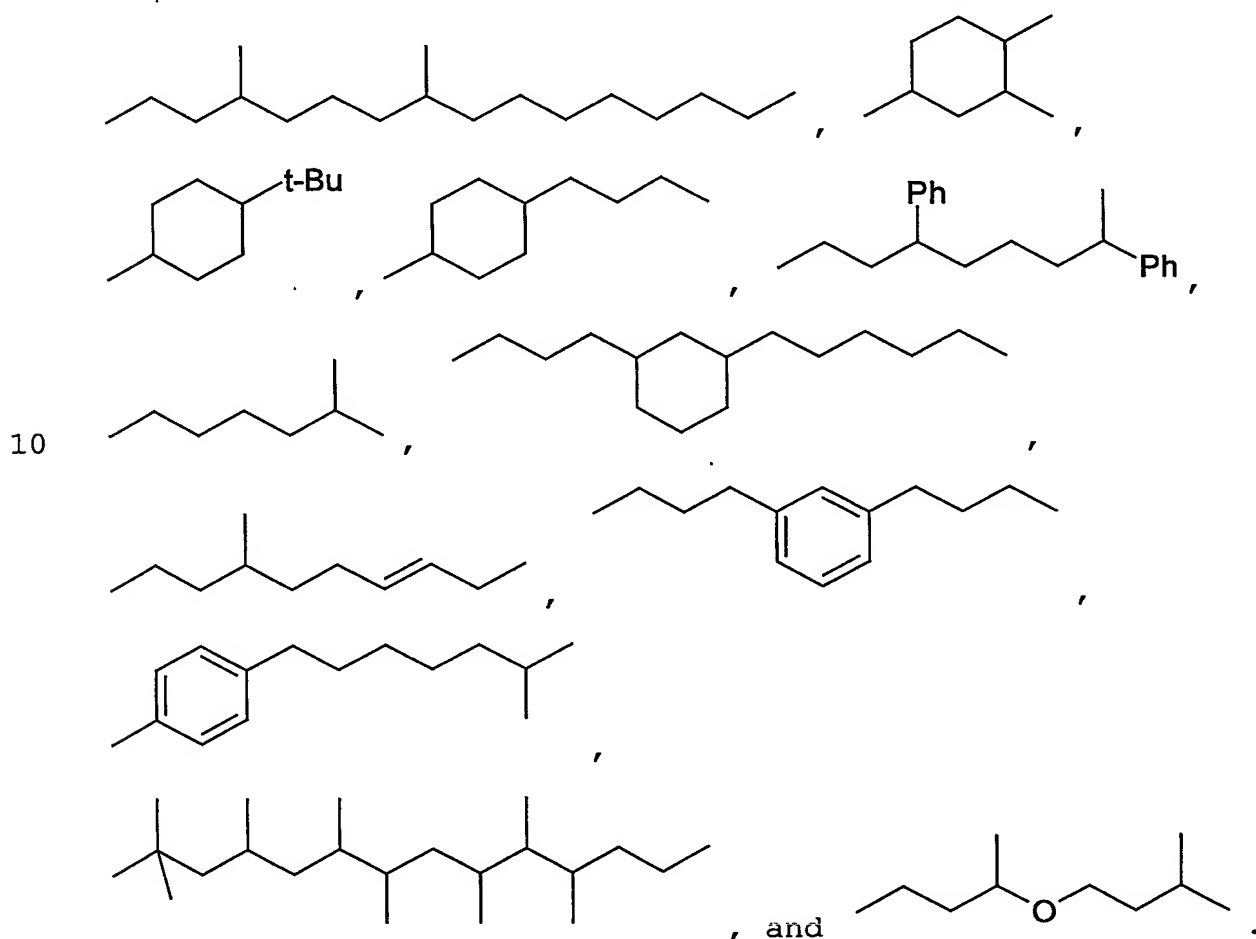


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exemplified preferred groups of the C8-C22-alkyl chain: -  
 $(\text{CH}_2)_7\text{CH}_3$ ,  $-(\text{CH}_2)_8\text{CH}_3$ ,  $-(\text{CH}_2)_9\text{CH}_3$ ,  $-(\text{CH}_2)_{10}\text{CH}_3$ ,  $-(\text{CH}_2)_{11}\text{CH}_3$ , -  
 $(\text{CH}_2)_{12}\text{CH}_3$ ,  $-(\text{CH}_2)_{13}\text{CH}_3$ ,  $-(\text{CH}_2)_{14}\text{CH}_3$ ,  $-(\text{CH}_2)_{15}\text{CH}_3$ ,  $-(\text{CH}_2)_{16}\text{CH}_3$ ; -  
 $(\text{CH}_2)_{17}\text{CH}_3$ ,  $-(\text{CH}_2)_{18}\text{CH}_3$ ,  $-(\text{CH}_2)_{19}\text{CH}_3$ ,  $-(\text{CH}_2)_{20}\text{CH}_3$ , and  $-(\text{CH}_2)_{21}\text{CH}_3$ .

5

The following are examples of branched and cyclic C8-C22-alkyl chains that may be used as R1 and R2 groups:



15 With reference to the above referenced structures, each structure has at least a C8-alkyl chain, be it cyclic, linear, or branched. The C8-C22-alkyl chain need not be continuous linkage of alkyl groups as exemplified in the

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ether above or phenyl spacer but it is preferred that the at least eight alkyl groups of the alkyl chain are in a continuous linkage without separation by a non alkyl group. The C8-C22-alkyl chain may contain some degree of  
5 unsaturation and may have pendent groups that do not take away from the hydrophobic nature of the C8-C22-alkyl chain. It is preferred that the C8-C22-alkyl chain is saturated. The C8-C22-alkyl chain may have a pendent phenyl substituent. Irrespective of a pendent group that is  
10 present the C8-C22-alkyl chain must have at least a C8-alkyl chain that may be cyclic or branched but preferably linear. A narrower range of alkyl chain is most preferred, namely a C10-C20 alkyl chain. A most preferred upper length of the alkyl chain is C18.

15

When one of R1 or R2 is a group containing a heteroatom capable of coordinating to a transition metal it is preferred that the group is a chelating 4 to 7 membered ring, preferably a 5 to 6 membered ring, comprising a  
20 heteroatom and that ring is connected to the nitrogens at the 3 or 7 position of the bispidon by a non co-ordinating 1 to 5 linking chain to the group, for example an ether linkage. It is most preferred that the 1 to 5 linking chain is a hydrocarbon chain, for example:  $-(CH_2)-$ ,  $-(CH_2)_2-$ ,  $-(CH_2)_3-$ ,  $-(CH_2)_4-$ , and  $-(CH_2)_5-$ , which are preferred. The  
25 chelating rings are preferably aromatic rings having as the heteroatom nitrogen. Most preferred groups are those defined for z spaced by at least one methylene chain between z and the nitrogens at the 3 or 7 position, most preferred  
30 is a pyridine group. Other preferred groups are tertiary

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amines, of which preferred classes thereof are as defined herein.

The group containing a heteroatom capable of coordinating to  
5 a transition metal is preferably selected from the group consisting of:

an optionally substituted tertiary amine of the form -C2-C4-alkyl-NR<sub>7</sub>R<sub>8</sub>, in which R<sub>7</sub> and R<sub>8</sub> are independently selected from the group consisting of straight chain, branched or  
10 cyclo C<sub>1</sub>-C<sub>12</sub> alkyl, benzyl, the -C2-C4-alkyl- of the -C2-C4-alkyl-NR<sub>7</sub>R<sub>8</sub> may be substituted by 1 to 4 C<sub>1</sub>-C<sub>2</sub>-alkyl, or may form part of a C<sub>3</sub> to C<sub>6</sub> alkyl ring, and in which R<sub>7</sub> and R<sub>8</sub> may together form a saturated ring containing one or more other heteroatoms;

15 a heterocycloalkyl: selected from the group consisting of: pyrrolinyl, pyrrolidinyl, morpholinyl, piperidinyl, piperazinyl, hexamethylene imine, 1,4-piperazinyl, tetrahydrothiophenyl, tetrahydrofuranyl, tetrahydropyranyl, and oxazolidinyl, wherein the heterocycloalkyl may be  
20 connected to the ligand via any atom in the ring of the selected heterocycloalkyl;

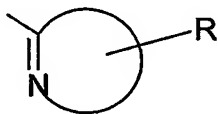
a -C<sub>1</sub>-C<sub>6</sub>-alkyl-heterocycloalkyl, wherein the heterocycloalkyl of the -C<sub>1</sub>-C<sub>6</sub>-alkyl-heterocycloalkyl is selected from the group consisting of: piperidinyl,  
25 piperidine, 1,4-piperazine, tetrahydrothiophene, tetrahydrofuran, pyrrolidine, and tetrahydropyran, wherein the heterocycloalkyl may be connected to the -C<sub>1</sub>-C<sub>6</sub>-alkyl via any atom in the ring of the selected heterocycloalkyl; and,

30 a -C<sub>1</sub>-C<sub>6</sub>-alkyl-heteroaryl, wherein the heteroaryl of the -C<sub>1</sub>-C<sub>6</sub>-alkyl-heteroaryl is selected from the group consisting

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of: pyridinyl, pyrimidinyl, pyrazinyl, triazolyl, pyridazinyl, 1,3,5-triazinyl, quinolinyl, isoquinolinyl, quinoxalinyl, imidazolyl, pyrazolyl, benzimidazolyl, thiazolyl, oxazolidinyl, pyrrolyl, carbazolyl, indolyl, and  
 5 isoindolyl, wherein the heteroaryl may be connected to the -C1-C6-alkyl via any atom in the ring of the selected heteroaryl and the selected heteroaryl is optionally substituted by a group selected from the group consisting of a -C1-C4-alkyl, -C0-C6-alkyl-phenol, -C0-C6-alkyl-  
 10 thiophenol, -C2-C4-alkyl-thiol, -C2-C4-alkyl-thioether, -C2-C4-alkyl-alcohol, -C2-C4-alkyl-amine, and a -C2-C4-alkyl-carboxylate.

Preferred z groups are same groups of the form:



15 selected from the group consisting of: pyridinyl; quinolinyl, pyrazolyl, imidazolyl; benzimidazolyl; and thiazolyl, and wherein R is -C0-C4-alkyl, most preferably z is pyridinyl optionally substituted by -C0-C4-alkyl.

20

Preferably one of R1 and R2 is selected from Me, CH<sub>2</sub>-C<sub>6</sub>H<sub>5</sub>, and pyridin-2-ylmethyl, wherein the pyridin-2-ylmethyl is optionally substituted by C1-C4-alkyl. Most preferably one of R1 and R2 is a pyridin-2-ylmethyl that is optionally  
 25 substituted by C1-C4-alkyl.

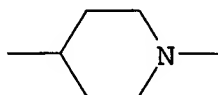
Of the tertiary amines that may be present at one of R1 and R2 the following are preferred:

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an optionally substituted tertiary amine of the form -C2-C4-alkyl-NR7R8, in which R7 and R8 are independently selected from the group consisting of straight chain, branched or cyclo C1-C12 alkyl, -CH2-C6H5, wherein the C6H5 is

5 optionally substituted by -C1-C4-alkyl or -O-C1-C4-alkyl, and pyridin-2-ylmethyl wherein the pyridine is optionally substituted by C1-C4-alkyl, the -C2-C4-alkyl- of the -C2-C4-alkyl-NR7R8 may be substituted by 1 to 4 C1-C2-alkyl, or may form part of a C3 to C6 alkyl ring, and in which R7 and R8  
 10 may together form a saturated ring containing one or more other heteroatoms. Optionally substituted tertiary amines of the form -C2-alkyl-NR7R8 and -C3-alkyl-NR7R8 are preferred.

The following structure

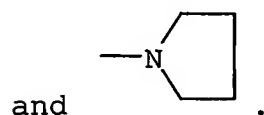
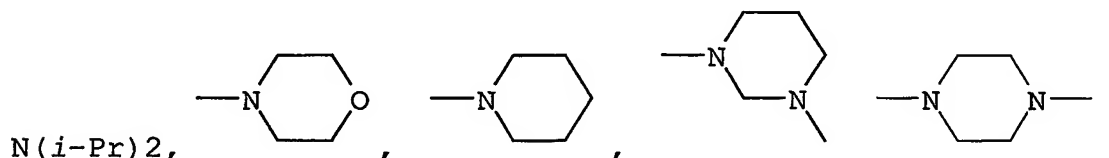


illustrates a preferred

-C3-alkyl-NR7R8.

15

The following are preferred -NR7R8 groups: -NMe2, -NEt2, -



20 Preferably R3 and R4 are selected from the group consisting of: -C(O)O-C1-C24-alkyl, -C(O)-O-C1-C24-aryl -CH2OC(O)C1-C20-alkyl, benzyl ester, phenyl, benzyl, CN, hydrogen, methyl, and C1-C4-OR wherein R is selected from the group consisting of H, C1-C24-alkyl or C(O)-C1-C24-alkyl. Most  
 25 preferably R3 and R4 are selected from -CH2OH, -C(O)-O-

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CH<sub>2</sub>C<sub>6</sub>H<sub>5</sub> and -C(O)O-C<sub>1</sub>-C<sub>6</sub>-alkyl. Of the -C(O)O-C<sub>1</sub>-C<sub>6</sub>-alkyl group -C(O)-O-CH<sub>3</sub>, and -C(O)-O-CH<sub>2</sub>CH<sub>3</sub> are most preferred. Most preferably R<sub>3</sub> = R<sub>4</sub>.

- 5 Preferred groups for X are C=O, CH<sub>2</sub>, C(OH)<sub>2</sub>, syn-CHOR and anti-CHOR, wherein R is H, C<sub>1</sub>-C<sub>24</sub>-alkyl or C(O)-C<sub>1</sub>-C<sub>24</sub>-alkyl. Most preferred group for X is C=O.

The catalyst may be used as a preformed complex of the  
 10 ligand and a transition metal. Alternatively, the catalyst may be formed from the free ligand that complexes with a transition metal already present in the water or that complexes with a transition metal present in the substrate. The composition may also be formulated as a composition of  
 15 the free ligand or a transition metal-substitutable metal-ligand complex, and a source of transition metal, whereby the complex is formed *in situ* in the medium.

The ligand forms a complex with one or more transition  
 20 metals, in the latter case for example as a dinuclear complex. Suitable transition metals include for example: manganese in oxidation states II-V, iron II-V, copper I-III, cobalt I-III, titanium II-IV, tungsten IV-VI, vanadium II-V and molybdenum II-VI.

25

The ligand forms a complex of the general formula (A1):



30 in which:

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M represents a metal selected from Mn(II)-(III)-(IV)-(V), Cu(I)-(II)-(III), Fe(II)-(III)-(IV)-(V), Co(I)-(II)-(III), Ti(II)-(III)-(IV), V(II)-(III)-(IV)-(V), Mo(II)-(III)-(IV)-(V)-(VI) and W(IV)-(V)-(VI), preferably selected  
 5 from Fe(II)-(III)-(IV)-(V);

L represents a ligand as herein defined, or its protonated or deprotonated analogue;

X represents a coordinating species selected from any mono, bi or tri charged anions and any neutral molecules  
 10 able to coordinate the metal in a mono, bi or tridentate manner, preferably selected from  $O^{2-}$ ,  $RBO_2^{2-}$ ,  $RCOO^-$ ,  $RCONR^-$ ,  $OH^-$ ,  $NO_3^-$ ,  $NO$ ,  $S^{2-}$ ,  $RS^-$ ,  $PO_4^{3-}$ ,  $PO_3OR^{3-}$ ,  $H_2O$ ,  $CO_3^{2-}$ ,  $HCO_3^-$ ,  $ROH$ ,  $N(R)_3$ ,  $ROO^-$ ,  $O_2^{2-}$ ,  $O_2^-$ ,  $RCN$ ,  $Cl^-$ ,  $Br^-$ ,  $OCN^-$ ,  $SCN^-$ ,  $CN^-$ ,  $N_3^-$ ,  $F^-$ ,  $I^-$ ,  $RO^-$ ,  $ClO_4^-$ , and  $CF_3SO_3^-$ , and more preferably selected from  
 15  $O^{2-}$ ,  $RBO_2^{2-}$ ,  $RCOO^-$ ,  $OH^-$ ,  $NO_3^-$ ,  $S^{2-}$ ,  $RS^-$ ,  $PO_3^{4-}$ ,  $H_2O$ ,  $CO_3^{2-}$ ,  $HCO_3^-$ ,  $ROH$ ,  $N(R)_3$ ,  $Cl^-$ ,  $Br^-$ ,  $OCN^-$ ,  $SCN^-$ ,  $RCN$ ,  $N_3^-$ ,  $F^-$ ,  $I^-$ ,  $RO^-$ ,  $ClO_4^-$ , and  $CF_3SO_3^-$ ;

Y represents any non-coordinated counter ion, preferably selected from  $ClO_4^-$ ,  $BR_4^-$ ,  $[MX_4]^-$ ,  $[MX_4]^{2-}$ ,  $PF_6^-$ ,  
 20  $RCOO^-$ ,  $NO_3^-$ ,  $RO^-$ ,  $N^+(R)_4$ ,  $ROO^-$ ,  $O_2^{2-}$ ,  $O_2^-$ ,  $Cl^-$ ,  $Br^-$ ,  $F^-$ ,  $I^-$ ,  $CF_3SO_3^-$ ,  $S_2O_6^{2-}$ ,  $OCN^-$ ,  $SCN^-$ ,  $H_2O$ ,  $RBO_2^{2-}$ ,  $BF_4^-$  and  $BPh_4^-$ , and more preferably selected from  $ClO_4^-$ ,  $BR_4^-$ ,  $[FeCl_4]^-$ ,  $PF_6^-$ ,  $RCOO^-$ ,  $NO_3^-$ ,  $RO^-$ ,  $N^+(R)_4$ ,  $Cl^-$ ,  $Br^-$ ,  $F^-$ ,  $I^-$ ,  $CF_3SO_3^-$ ,  $S_2O_6^{2-}$ ,  $OCN^-$ ,  $SCN^-$ ,  $H_2O$  and  $BF_4^-$ ;

25 a represents an integer from 1 to 10, preferably from 1 to 4;

k represents an integer from 1 to 10;

n represents an integer from 1 to 10, preferably from 1 to 4;

30 m represents zero or an integer from 1 to 20, preferably from 1 to 8; and

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each R independently represents a group selected from hydrogen, hydroxyl, -R' and -OR', wherein R' = alkyl, alkenyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl or a carbonyl derivative group, R' being optionally substituted by one or more functional groups E, wherein E independently represents a functional group selected from -F, -Cl, -Br, -I, -OH, -OR', -NH<sub>2</sub>, -NHR', -N(R')<sub>2</sub>, -N(R')<sub>3</sub><sup>+</sup>, -C(O)R', -OC(O)R', -COOH, -COO<sup>-</sup>(Na<sup>+</sup>, K<sup>+</sup>), -COOR', -C(O)NH<sub>2</sub>, -C(O)NHR', -C(O)N(R')<sub>2</sub>, heteroaryl, -R', -SR', -SH, -P(R')<sub>2</sub>, -P(O)(R')<sub>2</sub>, -P(O)(OH)<sub>2</sub>, -P(O)(OR')<sub>2</sub>, -NO<sub>2</sub>, -SO<sub>3</sub>H, -SO<sub>3</sub><sup>-</sup>(Na<sup>+</sup>, K<sup>+</sup>), -S(O)<sub>2</sub>R', -NHC(O)R', and -N(R')C(O)R', wherein R' represents cycloalkyl, aryl, arylalkyl, or alkyl optionally substituted by -F, -Cl, -Br, -I, -NH<sub>3</sub><sup>+</sup>, -SO<sub>3</sub>H, -SO<sub>3</sub><sup>-</sup>(Na<sup>+</sup>, K<sup>+</sup>), -COOH, -COO<sup>-</sup>(Na<sup>+</sup>, K<sup>+</sup>), -P(O)(OH)<sub>2</sub>, or -P(O)(O<sup>-</sup>(Na<sup>+</sup>, K<sup>+</sup>))<sub>2</sub>, and preferably each R independently represents hydrogen, optionally substituted alkyl or optionally substituted aryl, more preferably hydrogen or optionally substituted phenyl, naphthyl or C<sub>1-4</sub>-alkyl.

The counter ions Y in formula (A1) balance the charge z on the complex formed by the ligand L, metal M and coordinating species X. Thus, if the charge z is positive, Y may be an anion such as RCOO<sup>-</sup>, BPh<sub>4</sub><sup>-</sup>, ClO<sub>4</sub><sup>-</sup>, BF<sub>4</sub><sup>-</sup>, PF<sub>6</sub><sup>-</sup>, RSO<sub>3</sub><sup>-</sup>, RSO<sub>4</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, F<sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, or I<sup>-</sup>, with R being hydrogen, optionally substituted alkyl or optionally substituted aryl. If z is negative, Y may be a common cation such as an alkali metal, alkaline earth metal or (alkyl)ammonium cation.

Suitable counter ions Y include those which give rise to the formation of storage-stable solids. Preferred counter ions



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for the preferred metal complexes are selected from  $R^7COO^-$ ,  $ClO_4^-$ ,  $BF_4^-$ ,  $PF_6^-$ ,  $RSO_3^-$  (in particular  $CF_3SO_3^-$ ),  $RSO_4^-$ ,  $SO_4^{2-}$ ,  $NO_3^-$ ,  $F^-$ ,  $Cl^-$ ,  $Br^-$ , and  $I^-$ , wherein R represents hydrogen or optionally substituted phenyl, naphthyl or  $C_1$ - $C_4$  alkyl.

5

The novel compounds of Formula (I) as provided by the present invention also extend to their various transition metal complexes, the transition metal complexes are as discussed above with reference to (A1).

10

It will be appreciated that the complex (A1) can be formed by any appropriate means, including *in situ* formation whereby precursors of the complex are transformed into the active complex of general formula (A1) under conditions of storage or use. Preferably, the complex is formed as a well-defined complex or in a solvent mixture comprising a salt of the metal M and the ligand L or ligand L-generating species. Alternatively, the catalyst may be formed *in situ* from suitable precursors for the complex, for example in a solution or dispersion containing the precursor materials. In one such example, the active catalyst may be formed *in situ* in a mixture comprising a salt of the metal M and the ligand L, or a ligand L-generating species, in a suitable solvent. Thus, for example, if M is iron, an iron salt such as  $FeSO_4$  can be mixed in solution with the ligand L, or a ligand L-generating species, to form the active complex. Thus, for example, the composition may be formed from a mixture of the ligand L and a metal salt  $MX_n$  in which preferably  $n=1-5$ , more preferably 1-3. In another such example, the ligand L, or a ligand L-generating species, can be mixed with metal M ions present in the substrate or wash liquor to form the

30

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active catalyst *in situ*. Suitable ligand L-generating species include metal-free compounds or metal coordination complexes that comprise the ligand L and can be substituted by metal M ions to form the active complex according the  
5 formula (A1).

The catalysts according to the present invention may be used for laundry cleaning, hard surface cleaning (including cleaning of lavatories, kitchen work surfaces, floors,  
10 mechanical ware washing etc.). As is generally known in the art, bleaching compositions are also employed in waste-water treatment, pulp bleaching during the manufacture of paper, leather manufacture, dye transfer inhibition, food processing, starch bleaching, sterilisation, whitening in  
15 oral hygiene preparations and/or contact lens disinfection.

In typical washing compositions the level of the organic substance is such that the in-use level is from 1 $\mu$ M to 50mM, with preferred in-use levels for domestic laundry operations  
20 falling in the range 10 to 100  $\mu$ M. Higher levels may be desired and applied in industrial bleaching processes, such as textile and paper pulp bleaching. These levels reflect the amount of catalyst that may be present in a wash dose of a detergent composition. The bleaching composition  
25 comprises at least 1 ppb of the ligand or complex thereof.

In the context of the present invention, bleaching should be understood as relating generally to the decolourisation of stains or of other materials attached to or associated with  
30 a substrate. However, it is envisaged that the present invention can be applied where a requirement is the removal

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and/or neutralisation by an oxidative bleaching reaction of malodours or other undesirable components attached to or otherwise associated with a substrate. Furthermore, in the context of the present invention bleaching is to be  
5 understood as being restricted to any bleaching mechanism or process that does not require the presence of light or activation by light.

### Synthesis

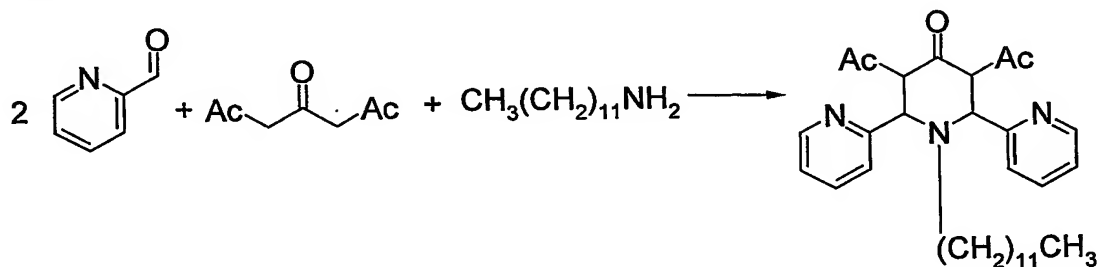
10 In addition to the utility of the ligands and complexes of the present invention as catalysts another advantage is that the ligands are generally relatively easy to synthesize in comparison to other ligands. The following is one example  
15 of a strategic synthetic approach; it will be evident to one skilled in the art of synthetic organic chemistry that many approaches may be taken to obtain ligands and complexes for use in the present invention. The ease of synthesis of the ligand of Formula (I) is dependent upon the nature of  
20 substituents about the structure. The ligands of Formula (I) are most preferably symmetric. Synthesis of these types of molecules are found in articles by U. Holzgrabe et al. in Arch. Pharm. (Weinheim, Ger.) 1992, 325, 657 and A. Samhammer et al. Arch. Pharm. (Weinheim, Ger.) 1984, 322, 557. Below is given a schematic example illustrating the  
25 ease of synthesis. The synthesis is shown in a two step synthesis, Scheme 1 and Scheme 2, but in some cases may be conducted as a "one-pot" synthesis depending upon the nature of the substituents. Nevertheless, where substituents at positions 7 and 3 are different a two step synthesis is  
30 preferred. The product of reaction as found in Scheme 1 is referred to as dimethyl 2,6-di-(2-pyridyl)-1-dodecane-

- 20 -

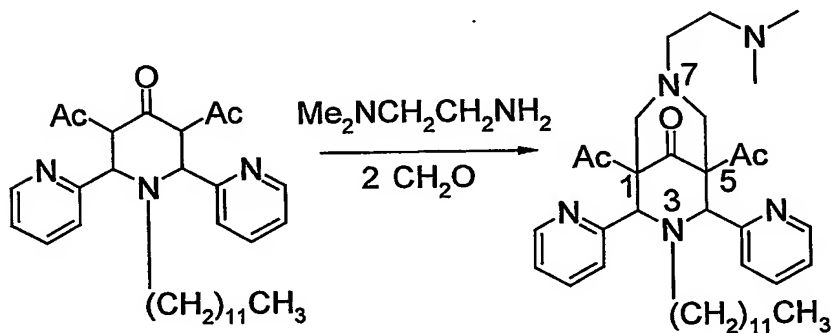
piperid-4-one-3,5-dicarboxylate, which can easily tautomerize to the enol. The synthesis is similar to that exemplified in R. Haller, K.W. Merz, *Pharm. Acta Helv.*, **1963**, 442.

5

Scheme 1



Scheme 2

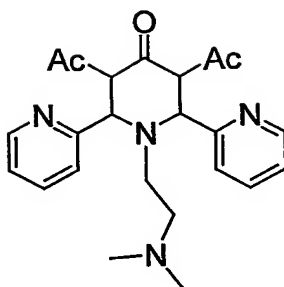


10

Another intermediate that may be produced according to the general teachings of Scheme 1 wherein CH<sub>3</sub>(CH)<sub>11</sub>NH<sub>2</sub> is replaced by Me<sub>2</sub>NCH<sub>2</sub>CH<sub>2</sub>NH<sub>2</sub> such that a product referred to as dimethyl-2,6-di-(2-pyridyl)-1-(N,N-dimethylamino)ethylene-piperid-4-one-3,5-dicarboxylate is produced, the structure of which is given below.

15

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One skilled in the art will appreciate that whilst Ac [-  
CO(O)Me] is an electron withdrawing group and electron  
withdrawing groups are generally preferred to facilitate  
5 synthesis other groups will also allow the reaction to  
proceed. Examples of suitable electron withdrawing groups  
are given above and will be evident to one skilled in the  
art. The reaction is also driven by precipitation of the  
product from solution.

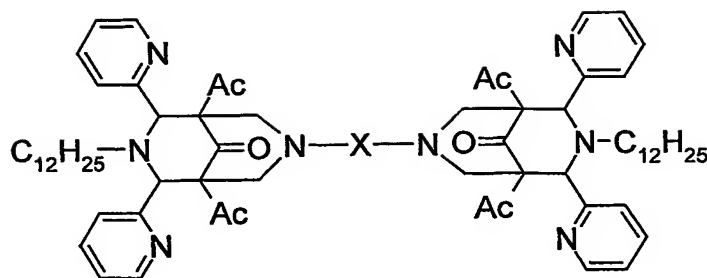
10

In instances, depending upon the nature of the substituents,  
for example a phenolic group, it will be necessary to  
protect certain functional groups. The choice of protecting  
groups during synthesis to prevent undesirable reactions  
15 will be evident to one skilled in the art. For a discussion  
of protecting groups in organic synthesis the reader is  
directed to T. W. Green and P. G. M. Wuts, Protective Groups  
In Organic Synthesis 3rd Ed.; J. Wiley and Sons, 1999.

20

It will be evident that if a diamine is substituted for  
Me<sub>2</sub>NCH<sub>2</sub>CH<sub>2</sub>NH<sub>2</sub> in the reaction illustrated in Scheme 2 two  
structures may be linked together via the 7 positions as  
found in the structure below.

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In addition, if a diamine is substituted for  $\text{CH}_3(\text{CH})_{11}\text{NH}_2$  in the reaction illustrated in Scheme 1 a structure is formed that is linked at the 3 positions. Obviously, this dimer would serve as a precursor to other dimer and polymer type structures. The present invention is confined to "monomer" ligands and not the dimer and polymer units linked by a covalent bond as described above. The term "monomer" as used herein is used to exclude these products in which covalently linked polyligand type structures are formed.

#### The Detergent Composition

The bleach catalyst and may be used in a detergent composition specifically suited for stain bleaching purposes, and this constitutes a second aspect of the invention. To that extent, the composition comprises a surfactant and optionally other conventional detergent ingredients. The invention in its second aspect provides an enzymatic detergent composition which comprises from 0.1 - 50 % by weight, based on the total detergent composition, of one or more surfactants. This surfactant system may in turn comprise 0 - 95 % by weight of one or more anionic surfactants and 5 to 100 % by weight of one or more nonionic surfactants. The surfactant system may additionally contain amphoteric or zwitterionic detergent compounds, but this in

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not normally desired owing to their relatively high cost. The enzymatic detergent composition according to the invention will generally be used as a dilution in water of about 0.05 to 2%.

5

The condition of "the balance carriers and adjunct ingredients" should be taken to be at least 1% wt/wt of a surfactant, preferably at least 5% wt/wt. Suitable carriers may be selected from water, fillers and builders.

10

In general, the nonionic and anionic surfactants of the surfactant system may be chosen from the surfactants described "Surface Active Agents" Vol. 1, by Schwartz & Perry, Interscience 1949, Vol. 2 by Schwartz, Perry & Berch, 15 Interscience 1958, in the current edition of "McCutcheon's Emulsifiers and Detergents" published by Manufacturing Confectioners Company or in "Tenside-Taschenbuch", H. Stache, 2nd Edn., Carl Hauser Verlag, 1981.

20

Suitable nonionic detergent compounds which may be used include, in particular, the reaction products of compounds having a hydrophobic group and a reactive hydrogen atom, for example, aliphatic alcohols, acids, amides or alkyl phenols with alkylene oxides, especially ethylene oxide either alone 25 or with propylene oxide. Specific nonionic detergent compounds are C<sub>6</sub>-C<sub>22</sub> alkyl phenol-ethylene oxide condensates, generally 5 to 25 EO, i.e. 5 to 25 units of ethylene oxide per molecule, and the condensation products of aliphatic C<sub>8</sub>-C<sub>18</sub> primary or secondary linear or branched alcohols with 30 ethylene oxide, generally 5 to 40 EO.

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Suitable anionic detergent compounds which may be used are usually water-soluble alkali metal salts of organic sulphates and sulphonates having alkyl radicals containing from about 8 to about 22 carbon atoms, the term alkyl being  
5 used to include the alkyl portion of higher acyl radicals. Examples of suitable synthetic anionic detergent compounds are sodium and potassium alkyl sulphates, especially those obtained by sulphating higher C<sub>8</sub>-C<sub>18</sub> alcohols, produced for example from tallow or coconut oil, sodium and potassium  
10 alkyl C<sub>9</sub>-C<sub>20</sub> benzene sulphonates, particularly sodium linear secondary alkyl C<sub>10</sub>-C<sub>15</sub> benzene sulphonates; and sodium alkyl glyceryl ether sulphates, especially those ethers of the higher alcohols derived from tallow or coconut oil and synthetic alcohols derived from petroleum. The preferred  
15 anionic detergent compounds are sodium C<sub>11</sub>-C<sub>15</sub> alkyl benzene sulphonates and sodium C<sub>12</sub>-C<sub>18</sub> alkyl sulphates. Also applicable are surfactants such as those described in EP-A-328 177 (Unilever), which show resistance to salting-out, the alkyl polyglycoside surfactants described  
20 in EP-A-070 074, and alkyl monoglycosides.

Preferred surfactant systems are mixtures of anionic with nonionic detergent active materials, in particular the groups and examples of anionic and nonionic surfactants  
25 pointed out in EP-A-346 995 (Unilever). Especially preferred is surfactant system that is a mixture of an alkali metal salt of a C<sub>16</sub>-C<sub>18</sub> primary alcohol sulphate together with a C<sub>12</sub>-C<sub>15</sub> primary alcohol 3-7 EO ethoxylate.

30 The nonionic detergent is preferably present in amounts greater than 10%, e.g. 25-90% by weight of the surfactant



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system. Anionic surfactants can be present for example in amounts in the range from about 5% to about 40% by weight of the surfactant system.

- 5 The detergent composition may take any suitable physical form, such as a powder, granular composition, tablets, a paste or an anhydrous gel.

PEROXYGEN BLEACH OR SOURCE THEREOF

- 10 In a peroxy bleaching mode the composition of the present invention uses a peroxy species to bleach a substrate. The peroxy bleaching species may be a compound which is capable of yielding hydrogen peroxide in aqueous solution. Hydrogen peroxide sources are well known in the art. They include the
- 15 alkali metal peroxides, organic peroxides such as urea peroxide, and inorganic persalts, such as the alkali metal perborates, percarbonates, perphosphates persilicates and persulphates. Mixtures of two or more such compounds may also be suitable.

20

- Particularly preferred are sodium perborate tetrahydrate and, especially, sodium perborate monohydrate. Sodium perborate monohydrate is preferred because of its high active oxygen content. Sodium percarbonate may also be
- 25 preferred for environmental reasons. The amount thereof in the composition of the invention usually will be within the range of about 1-35% by weight, preferably from 5-25% by weight. One skilled in the art will appreciate that these amounts may be reduced in the presence of a bleach precursor
- 30 e.g., N,N,N',N'-tetraacetyl ethylene diamine (TAED).

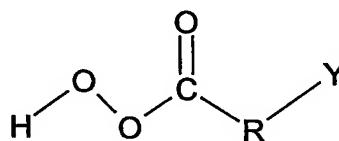
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Another suitable hydrogen peroxide generating system is a combination of a C1-C4 alkanol oxidase and a C1-C4 alkanol, especially a combination of methanol oxidase (MOX) and ethanol. Such combinations are disclosed in International  
5 Application PCT/EP 94/03003 (Unilever), which is incorporated herein by reference.

Alkylhydroxy peroxides are another class of peroxy bleaching compounds. Examples of these materials include cumene  
10 hydroperoxide and t-butyl hydroperoxide.

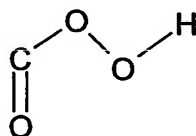
Organic peroxyacids may also be suitable as the peroxy bleaching compound. Such materials normally have the general formula:

15



20

wherein R is an alkylene or substituted alkylene group containing from 1 to about 20 carbon atoms, optionally having an internal amide linkage; or a phenylene or substituted phenylene group; and Y is hydrogen, halogen, alkyl, aryl, an imido-aromatic or non-aromatic group, a COOH  
or



25 group or a quaternary ammonium group.

Typical monoperoxy acids useful herein include, for example:

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- (i) peroxybenzoic acid and ring-substituted peroxybenzoic acids, e.g. peroxy-.alpha.-naphthoic acid;  
(ii) aliphatic, substituted aliphatic and arylalkyl monoperoxyacids, e.g. peroxy lauric acid, peroxy stearic acid  
5 and N,N-phthaloylaminoperoxy caproic acid (PAP); and  
(iii) 6-octylamino-6-oxo-peroxyhexanoic acid.

Typical diperoxyacids useful herein include, for example:

- 10 (iv) 1,12-diperoxydodecanedioic acid (DPDA);  
(v) 1,9-diperoxyazelaic acid;  
(vi) diperoxybrassicilic acid; diperoxysebasic acid and  
diperoxyisophthalic acid;  
(vii) 2-decyldiperoxybutane-1,4-diotic acid; and  
15 (viii) 4,4'-sulphonylbisperoxybenzoic acid.

Also inorganic peroxyacid compounds are suitable, such as for example potassium monopersulphate (MPS). If organic or inorganic peroxyacids are used as the peroxygen compound,  
20 the amount thereof will normally be within the range of about 2-10% by weight, preferably from 4-8% by weight.

Peroxyacid bleach precursors are known and amply described in literature, such as in the British Patents 836988;  
25 864,798; 907,356; 1,003,310 and 1,519,351; German Patent 3,337,921; EP-A-0185522; EP-A-0174132; EP-A-0120591; and U.S. Pat. Nos. 1,246,339; 3,332,882; 4,128,494; 4,412,934 and 4,675,393. Another useful class of peroxyacid bleach precursors is that of the cationic i.e. quaternary ammonium  
30 substituted peroxyacid precursors as disclosed in US Pat. Nos. 4,751,015 and 4,397,757, in EP-A0284292 and

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EP-A-331229. Examples of peroxyacid bleach precursors of this class are:

2-(N,N,N-trimethyl ammonium) ethyl sodium-4-sulphonphenyl  
5 carbonate chloride (SPCC);

N-octyl-N,N-dimethyl-N10-carbophenoxy decyl ammonium  
chloride (ODC);

10 3-(N,N,N-trimethyl ammonium) propyl sodium-4-sulphophenyl  
carboxylate; and

N,N,N-trimethyl ammonium toluyloxy benzene sulphonate.

15 A further special class of bleach precursors is formed by  
the cationic nitriles as disclosed in EP-A-303520 and in  
European Patent Specification No.'s 458396 and 464880.

Any one of these peroxyacid bleach precursors can be used in  
20 the present invention, though some may be more preferred  
than others.

Of the above classes of bleach precursors, the preferred  
classes are the esters, including acyl phenol sulphonates  
25 and acyl alkyl phenol sulphonates; the acyl-amides; and the  
quaternary ammonium substituted peroxyacid precursors  
including the cationic nitriles. Examples of said preferred  
peroxyacid bleach precursors or activators are sodium-4-  
benzoyloxy benzene sulphonate (SBOBS); N,N,N'-tetraacetyl  
30 ethylene diamine (TAED); sodium-1-methyl-2-benzoyloxy  
benzene-4-sulphonate; sodium-4-methyl-3-benzoyloxy benzoate;

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SPCC; trimethyl ammonium toluyloxy-benzene sulphonate; sodium nonanoyloxybenzene sulphonate (SNOBS); sodium 3,5,5-trimethyl hexanoyl-oxybenzene sulphonate (STHOBS); and the substituted cationic nitriles.

5

Other classes of bleach precursors for use with the present invention are found in WO0015750, for example 6-(nonanamidocaproyl)oxybenzene sulphonate.

10 The precursors may be used in an amount of up to 12%, preferably from 2-10% by weight, of the composition.

#### Enzymes

The detergent compositions of the present invention may additionally comprise one or more enzymes, which provide cleaning performance, fabric care and/or sanitation benefits.

Said enzymes include oxidoreductases, transferases, hydrolases, lyases, isomerases and ligases. Suitable members of these enzyme classes are described in Enzyme nomenclature 1992: recommendations of the Nomenclature Committee of the International Union of Biochemistry and Molecular Biology on the nomenclature and classification of enzymes, 1992, ISBN 0-12-227165-3, Academic Press.

Examples of the hydrolases are carboxylic ester hydrolase, thiolester hydrolase, phosphoric monoester hydrolase, and phosphoric diester hydrolase which act on the ester bond; glycosidase which acts on O-glycosyl compounds; glycosylase hydrolysing N-glycosyl compounds; thioether hydrolase which

- 30 -

acts on the ether bond; and exopeptidases and endopeptidases which act on the peptide bond. Preferable among them are carboxylic ester hydrolase, glycosidase and exo- and endopeptidases. Specific examples of suitable hydrolases

5 include (1) exopeptidases such as aminopeptidase and carboxypeptidase A and B and endopeptidases such as pepsin, pepsin B, chymosin, trypsin, chymotrypsin, elastase, enteropeptidase, cathepsin B, papain, chymopapain, ficain, thrombin, plasmin, renin, subtilisin, aspergillopepsin,

10 collagenase, clostripain, kallikrein, gastricsin, cathepsin D, bromelain, chymotrypsin C, urokinase, cucumisin, oryzin, proteinase K, thermomycolin, thermitase, lactocepin, thermolysin, bacillolysin. Preferred among them is subtilisin; (2) glycosidases such as  $\alpha$ -amylase,  $\beta$ -amylase,

15 glucoamylase, isoamylase, cellulase, endo-1,3(4)- $\beta$ -glucanase ( $\beta$ -glucanase), xylanase, dextranase, polygalacturonase (pectinase), lysozyme, invertase, hyaluronidase, pullulanase, neopullulanase, chitinase, arabinosidase, exocellobiohydrolase, hexosaminidase, mycodextranase, endo-

20 1,4- $\beta$ -mannanase (hemicellulase), xyloglucanase, endo- $\beta$ -galactosidase (keratanase), mannanase and other saccharide gum degrading enzymes as described in WO-A-99/09127. Preferred among them are  $\alpha$ -amylase and cellulase; (3) carboxylic ester hydrolase including carboxylesterase,

25 lipase, phospholipase, pectinesterase, cholesterol esterase, chlorophyllase, tannase and wax-ester hydrolase. Preferred among them is lipase.

Examples of transferases and ligases are glutathione S-

30 transferase and acid-thiol ligase as described in

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WO-A-98/59028 and xyloglycan endotransglycosylase as described in WO-A-98/38288.

5 Examples of lyases are hyaluronate lyase, pectate lyase, lipex, chondroitinase, pectin lyase, alginase II. Especially preferred is pectolyase, which is a mixture of pectinase and pectin lyase.

10 Examples of the oxidoreductases are oxidases such as glucose oxidase, methanol oxidase, bilirubin oxidase, catechol oxidase, laccase, peroxidases such as ligninase and those described in WO-A-97/31090, monooxygenase, dioxygenase such as lipoxxygenase and other oxygenases as described in WO-A-99/02632, WO-A-99/02638, WO-A-99/02639 and the  
15 cytochrome based enzymatic bleaching systems described in WO-A-99/02641.

The activity of oxidoreductases, in particular the phenol oxidising enzymes in a process for bleaching stains on  
20 fabrics and/or dyes in solution and/or antimicrobial treatment can be enhanced by adding certain organic compounds, called enhancers. Examples of enhancers are 2,2'-azo-bis-(3-ethylbenzo-thiazoline-6-sulphonate (ABTS) and Phenothiazine-10-propionate (PTP). More enhancers are  
25 described in WO-A-94/12619, WO-A-94/12620 , WO-A-94/12621, WO-A-97/11217, WO-A-99/23887. Enhancers are generally added at a level of 0.01% to 5% by weight of detergent composition.

30 Builders, polymers and other enzymes as optional ingredients may also be present as found in WO0060045.

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Suitable detergency builders as optional ingredients may also be present as found in WO0034427.

The invention will now be further illustrated by way of the following non-limiting examples.

#### EXPERIMENTAL

Dimethyl 2,4-di-(2-pyridyl) -3-methyl-7-(pyridin-2-ylmethyl)-3,7-diaza-bicyclo[3.3.1]nonan-9-one-1,5-dicarboxylate (N2py3o-C1) and the iron complex thereof FeN2py3o-C1 was prepared as described in PCT/EP01/13314. The bispidons instead of having a methyl group (C1) at the 3 position, namely isobutyl, (n-hexyl) C6, (n-octyl) C8, (n-dodecyl) C12 and (n-tetradecyl) C14 were prepared in an analogous manner. Unless otherwise indicated the alkyl chain substituents were linear.

#### BLEACHING EXPERIMENTS (peroxide mode)

In an aqueous solution containing 5 g/l SKIP, 2003™ in 19 FH water hardness (opzoeken) and 1 mM hydrogen peroxide tomato-soya oil stained or curry-soya oil stained cloths were added and kept in contact with the solution whilst agitating for 30 minutes at 30 °C. Comparative experiments were performed using 10 µM of the metal complex referred to in the table below.

After the wash, the cloths were rinsed with water and subsequently dried at 30 °C and the change in colour was measured immediately after drying for 3 h at 45 °C with a Linotype-Hell scanner (ex Linotype). The change in colour



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(including bleaching) is expressed as the  $\Delta E$  value versus white and the values in the tables are  $100 - \Delta E$ ; a higher SRI value means a cleaner cloth (100=white). The measured colour difference ( $\Delta E$ ) between the washed cloth and the unwashed cloth is defined as follows:

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

wherein  $\Delta L$  is a measure for the difference in darkness between the washed and unwashed test cloth;  $\Delta a$  and  $\Delta b$  are measures for the difference in redness and yellowness respectively between both cloths. With regard to this colour measurement technique, reference is made to Commission International de l'Eclairage (CIE); Recommendation on Uniform Colour Spaces, colour difference equations, psychometric colour terms, supplement no 2 to CIE Publication, no 15, Colorimetry, Bureau Central de la CIE, Paris 1978. The results are shown below in the tables and are listed.

20

Tomato oil (TOL)

	100- $\Delta E$
Blank	63
FeN2py3o-C1	70
Fe(N2py3o)-isobutyl	74
FeN2py3o-C6	88
FeN2py3o-C8	95
Fe(N2py3o)Cl2	95
Fe(N2py3o)Cl4	73

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Curry oil (COL)/OMO	100-ΔE
Blank	45
FeN <sub>2</sub> py <sub>3</sub> o-C1	50
FeN <sub>2</sub> py <sub>3</sub> o-C6	55
FeN <sub>2</sub> py <sub>3</sub> o-C8	54
Fe (N <sub>2</sub> py <sub>3</sub> o) C12	57